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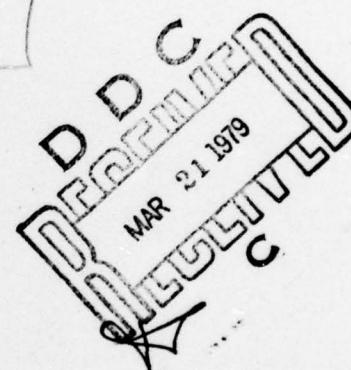
(6) Assistance in the Design
of the SWF System

(14) CCA-79-13

(10) Donald E./Eastlake, III

Joanne Z./Sattley

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(12) 32 p.

(11) 30 January 30, 1979

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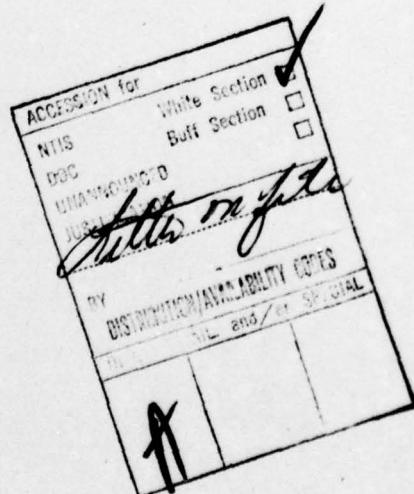
1.  Introduction

During 1978, Computer Corporation of America assisted  the
Vela  Seismological  Center  (VSC)  and  the  Seismic Data
Analysis  Center  (SDAC)  in  the  design,  creation,  and
management  of  the  Signal Waveform Files (SWF).  The SWF
system is intended to make all of the recent "interesting"
seismic data of the Vela Seismological  Network  available
in  the  Datacomputer.   This  work  is continuing in 1979
under a follow on proposal.

The Datacomputer is a unique network data utility  [MARILL
and  STERN] developed and operated by Computer Corporation
of America for  the  Defense  Advanced  Research  Projects
Agency.    It  is  designed  for  support  of  very  large
databases  and  shared  remote  access  by  heterogeneous
computers [CCA].   The  Datacomputer  provides very large
on-line capacity through an Ampex  TBM  video  tape  based
mass  storage system [EASTLAKE].  This mass storage system
is presently configured for approximately 200 billion bits
of on-line capacity.  Data that has been stored  into  the
system  in  excess  of that amount is kept in off-line TBM
tapes.

The Velanet is a worldwide network consisting of seismic
instruments, for example, communications channels, data
processors, and data storage systems. Figure 1.1 shows
the logical configuration of the Velanet at the beginning
of 1978. Figure 1.2, provided by SDAC, shows the
geographic configuration of the Vela Network. The
Datacomputer is the primary storage and retrieval resource
in the seismic data activity [DORIN and EASTLAKE].

The seismic data stored in the Datacomputer is structured
into files of several types. Two of these types, status
and event files, are relatively small but valuable and it
is presently planned that they be kept on line
indefinitely. Status files give information on the status
of seismic instruments, their calibration, operationality,
and the like. Event files list seismic events of
significance and include many pieces of information on
each event such as location, depth, severity, method of
calculation, error bounds, region, etc. In addition, each
event in an Event Summary File is accompanied by a list of
"arrivals"; that is, a list of times, seismic stations,
and other information that relates the event to the
arrival of seismic disturbances at particular
seismometers.

Velanet Configuration                                         Figure 1.1
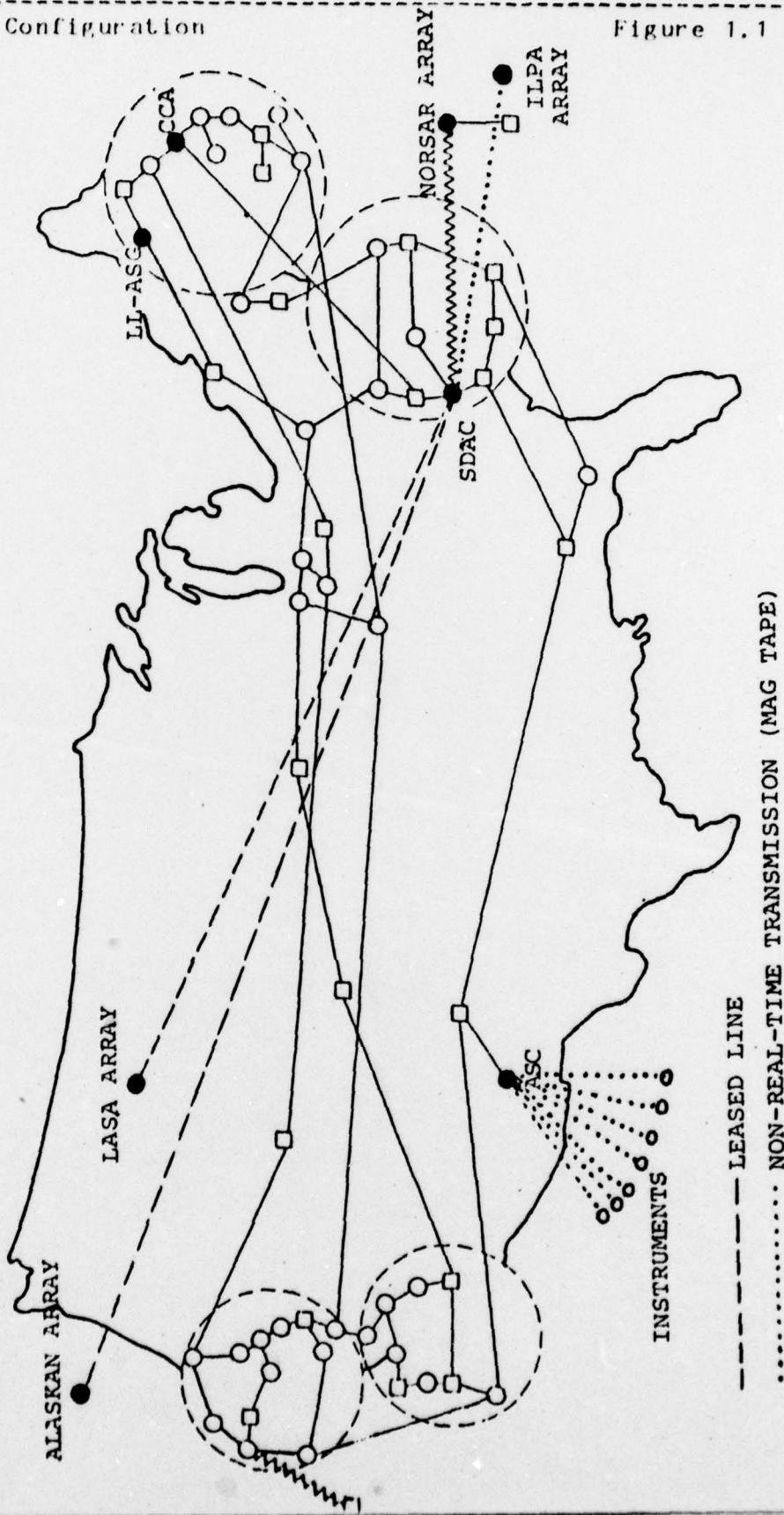
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Geographical Configuration                                    Figure 1.2



LEGEND

★ - SDAC

▲ - MASS STORE

● - REAL-TIME STATIONS

□ - SRO/HGLP STATIONS
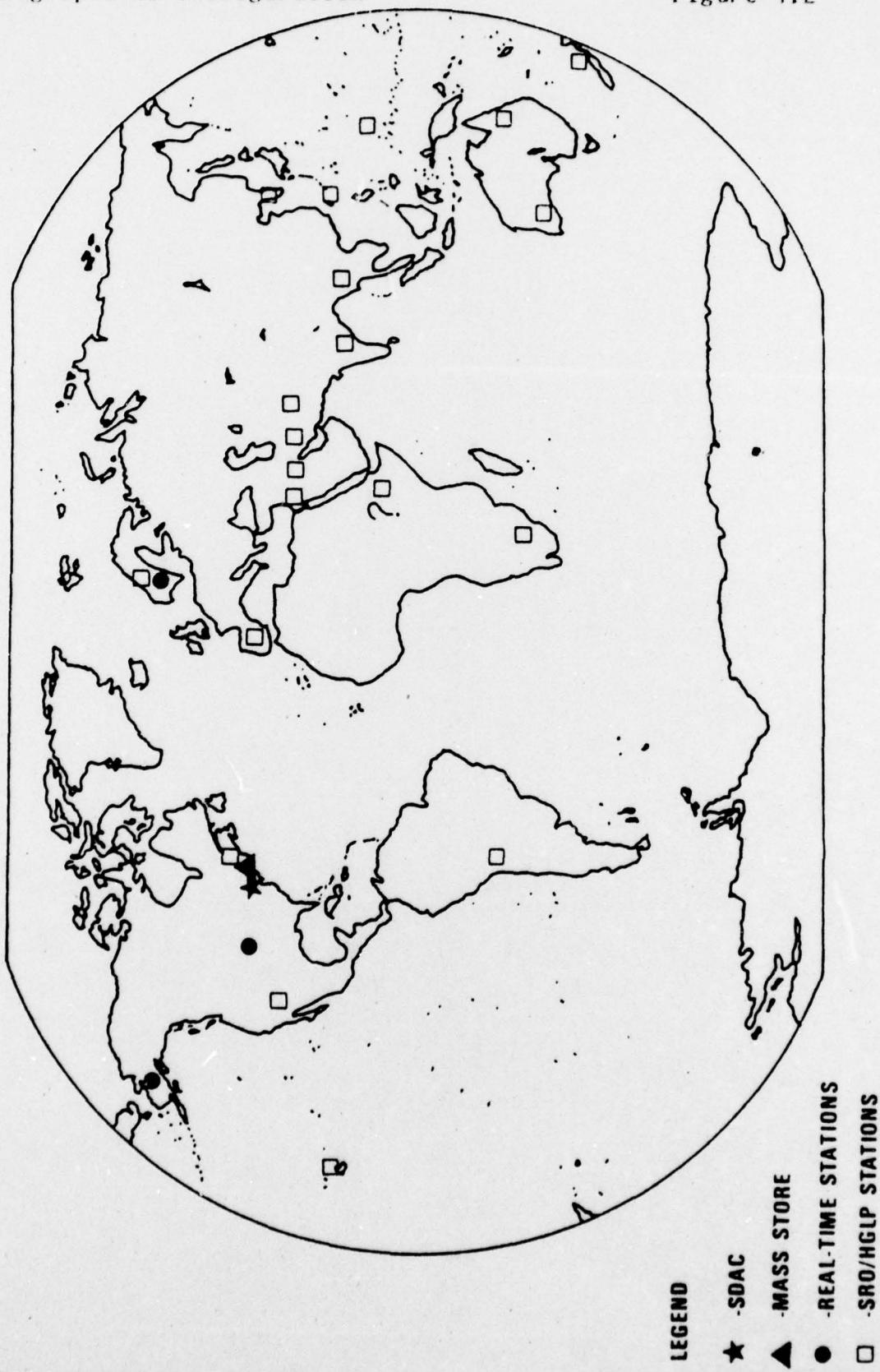
Other than the status and event files, there are seismic files in the Datacomputer which consist primarily of time series seismometer readings. For the real time seismic arrays in the Vela network, this data is continuous, with missing data areas only when the real time system was not fully operational. For the Seismic Research Observatory (SRO) data, long period data consisting of one sample per second is recorded and later stored continuously. Short period data, with ten samples per second, is only recorded at the SRO, and later stored in the Datacomputer, if it exceeds a local threshold. The volume of data in these files makes it impossible to keep them on line for more than a couple of months in the current mass storage system configuration before newer data crowds out the old which must be put off-line.

Recently a new type of seismometer data readings file has been created, the Signal Waveform File. It is described in the following section.

2.   The Signal Waveform File


The seismic files that are expected to be the most  useful
for seismological research are the Event Summary Files and
the Signal Waveform Files.

The  Signal  Waveform  Files  will  contain  seismic  data
segments that relate  directly  to  the  detected  seismic
events  in  the  Event  Summary  File  and also noteworthy
unassociated  seismic  arrivals  at   particular   seismic
stations.   The files will not contain other seimsic data.
This  represents a reduction in data of over  an  order  of
magnitude.   There  is a corresponding beneficial increase
in the amount of time that the data can remain on-line for
a particular mass memory configuration and a  decrease   in
the  amount  of  time it takes to perform certain types of
processing over the data.

2.1  SDAC Processing

Much of the processing involved in forming the SWF is
performed by SDAC.  The determination of the events and
seismic signal arrival times and stations for the PESF
file is SDAC's responsibility.  These PESF entries control
the subsequent formation of the SWF.

SDAC will also store directly into the SWF in the
Datacomputer all of the signal waveforms except those from
the non-array seismic research observatories (SROs).  The
storage SDAC will perform involves the selection of the
appropriate data from that arriving in real time from
seismic arrays and later the selection and transmission of
the array data arriving at SDAC by magnetic tape from
ILPA, the Iranian array, and KSRS, the Korean array.

Figure 2.1, provided by SDAC, shows the processing
involved from the SDAC viewpoint.

------------------------------------------------------------
SDAC processing                                     Figure 2.1
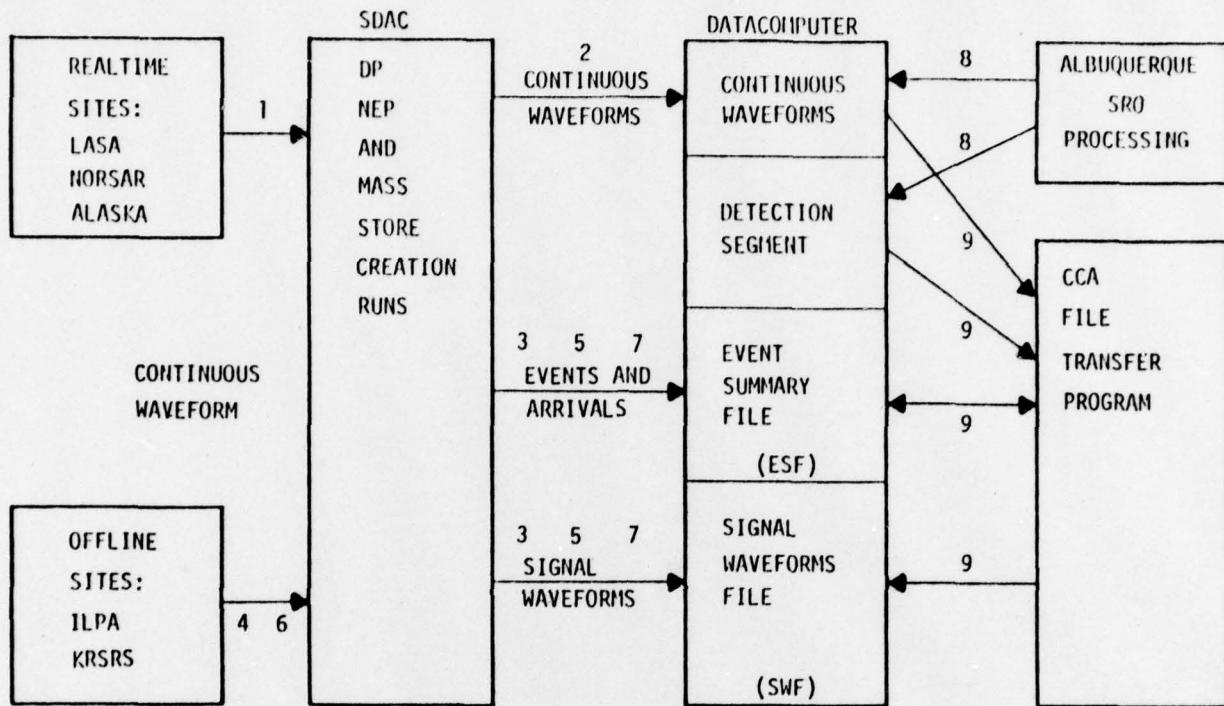


1 - waveform data from realtime sites arrives at the SDAC
2 - data from the realtime sites goes to the DATACOMPUTER
3 - ESF/SWF including realtime sites signal waveforms go to the DATA COMPUTER
4 - ILPA field tape arrives at SDAC
5 - ILPA signal waveforms go to DATACOMPUTER
6 - KSRS field tape arrives at the SDAC
7 - KSRA signal waveforms go to the DATACOMPUTER
8 - ALBEQUERQUE reviewed SRO data goes to the DATACOMPUTER
9 - CCA FILE TRANSFER PROGRAM completes signal waveforms

## 2.2  CCA Processing

CCA processing involved in the creation of the SWF is described in detail in several other technical reports [EASTLAKE and SATTLEY] [SATTLEY a] [SATTLEY b]. In brief, it involves scanning the Event Summary Files for flagged arrivals referring to SRO data, seeking out the data from the SRO files in the Datacomputer, moving the data to the SWF, and updating the ESF to reflect this as shown in Figure 2.2. If the data requested for the arrival does not exist, the ESF flag is reset to an indication that no waveform data will be available.

In order to efficiently locate and extract the discontinuously recorded and stored short period SRO data, the CCA software must first compute a summary file of the available data. Since chunks of short period SRO data are recorded only if the seismic activity exceeds a local threshold at the seismometer involved, the entries in this summary file are referred to as detections.

These short period SRO detections list files are of interest in their own right and are being regularly compiled by CCA, stored in the Datacomputer, and made available to seismic researchers.
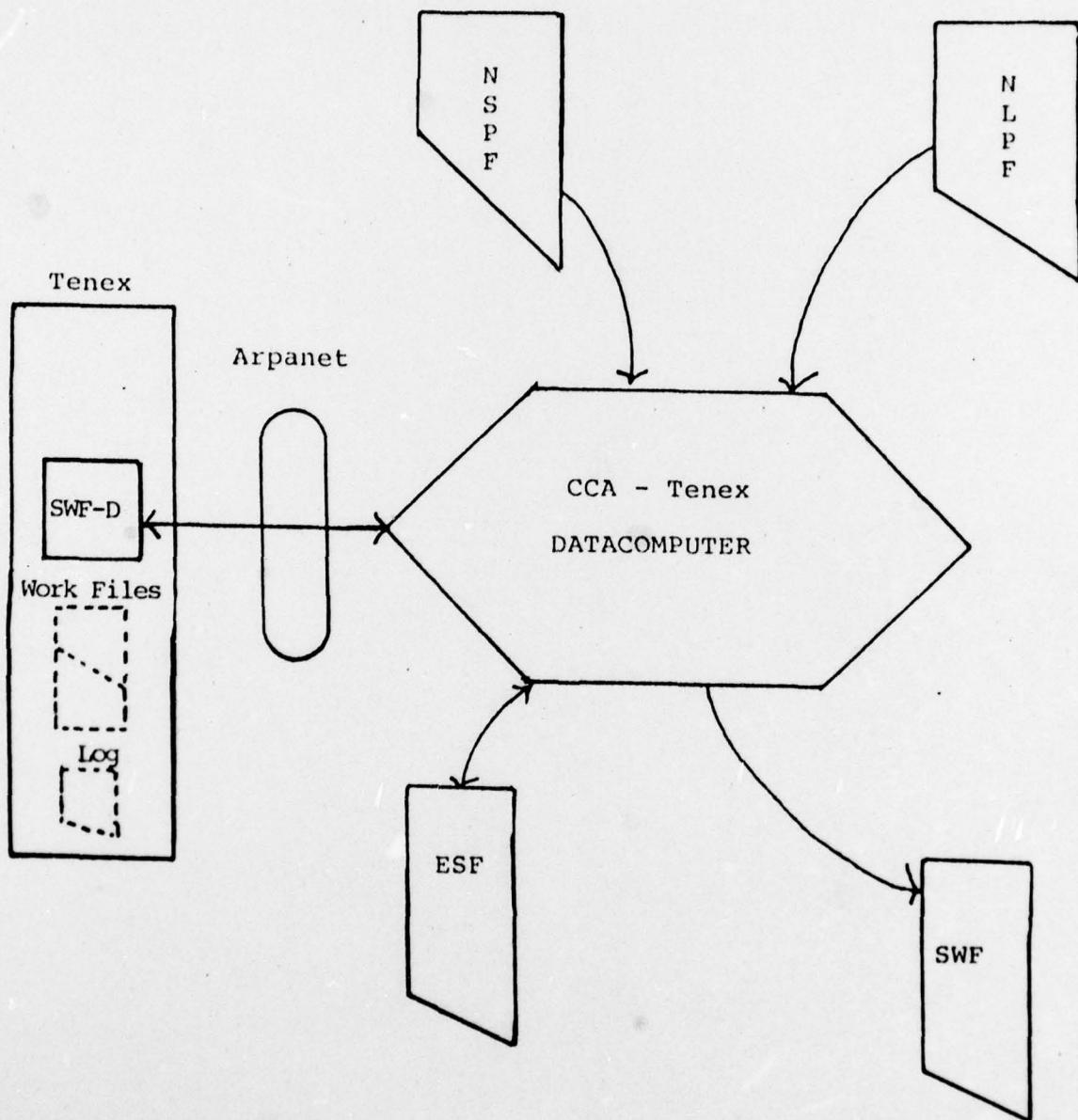
Prior to CCA compilation of these files, the Lincoln Laboratories Applied Seismology Group compiled similar files with less information in them. Because of the Datacomputer's field name matching and selective data extraction features, LL-ASG was able to use the CCA compiled files by simply changing their programs to reference them. No other changes were necessary as the additional data fields that LL-ASG did not want were stripped by the Datacomputer from the data sent to them.

3.  Assistance


CCA assisted the Vela Seismological Center and the Seismic
Data Analysis Center (SDAC) during  the  course  of  this
contract,  by  consultation,  in the design, creation, and
management of the SWF and in the use of  the  Datacomputer
for  that  end.   This  assistance  was  rendered  through
meetings held at SDAC, memoranda, telephone consultations,
and the like as described below.


3.1  Meeting 16 January 1978


This all day meeting concerned both the SWF and  also  the
specific  component  of  the  SWF  system  that  CCA  is
implementing.  This component moves SRO data into the  SWF
under  the  control of entries placed in the Event Summary
Files by SDAC.  CCA was represented by Donald E. Eastlake.
The following points were among those covered:

a.  There was considerable discussion of the volume  of
    data  to  be involved in the SWF.  CCA commented on
    the effects of various options on  TBM  tape  usage
    and on-line retention time.

b.  It was decided that CCA would not rotate SRO
    components (changing them from north-south and
    east-west to radial and tangental with respect to
    the event) because the Datacomputer would be much
    less efficient at doing this than would the
    specially equipped processors at SDAC.

c.  The method of flagging the arrivals in the Event
    Summary Files which CCA will handle was decided.  A
    field that normally has a "Y" or an "N", to
    indicate that a waveform is or is not available in
    the SWF, will be set to "T" to flag arrivals
    needing processing.  The questions as to how much
    data should be moved into the SWF for the arrival
    were to be answered by look up in a simple table to
    be supplied to CCA by SDAC.

d.  It was decided that there would be only one type of
    SWF file.  This would initially have the real time
    waveforms and the SRO and non-real time data would
    be appended.  Earlier plans had called for a
    preliminary and final version of each SWF file.

e.   Whether there would be only one type or both
     preliminary and final versions of the Event Summary
     File was left undecided. CCA urged that the
     initial event files, of which there are one per
     day, be later condensed into monthly final event
     summary files. These fewer monthly files would be
     easier to deal with. In the process of
     transferring from preliminary to final ESF,
     predicted arrivals for which waveform data will not
     be available can be deleted.

f.   There was considerable discussion of scheduling and
     testing for developing the SWF system. Using the
     SDAC-UNIX system for retrievals to independently
     test the output of CCA's component of the SWF
     system was suggested.

3.2  Meeting 13 April 1978

The primary purpose of this meeting, which was held at SDAC in Alexandria Virginia, was to review a Design Plan Draft for the SWF prepared by Joe Greenhalgh of Teledyne Geotech. CCA was represented by Donald E. Eastlake and Joanne Z. Sattley.

After general discussion of SDAC's plans, an explanation was given of CCA's plans to implement its part of the system (as described in Section 2.2 above).

Numerous details of the SDAC plan were decided, many on the basis of seismological considerations. All questions that came up concerning the volume of data to go into the SWF were initially decided in favor of more data.

CCA urged SDAC to get some real predicted SRO arrival entries into the ESF file as soon as possible so assist our development of our part of the SWF system. (Such entries were not successfully entered into the ESF by SDAC until 1979.)

A question arose as to one piece of information to be included in the SWF with the data CCA is to move into the

SWF.   This is a scale factor giving the value, in nanometers of displacement, of the least significant bit of the seismic data.   SDAC is required to keep up to date on the scale factors of all seismic instruments involved, which change at unpredictable intervals, but CCA personnel generally have no need for this information.   It was agreed to have SDAC include the scale factor in an ESF field when it stores arrivals for CCA to handle.   This field would be copied to the SWF and then overwritten when CCA updates the ESF to reflect its completed handling of the arrival.

Another question brought up was whether or not abbreviations could be used in the arrivals SDAC will store in the ESF.   There are cases where three seismic channels always appear in conjunction and where the waveform data will either be available for all or none of the channels.   It was agreed that, in such cases, the use of abbreviations was reasonable and beneficial.

SDAC issued a document on 31 July 1978 based on this meeting and on the design draft circulated at it [GEOTECH].

3.3  Memoranda


Two memoranda were produced by CCA in  assistance  of  the
seismic Datacomputer application.

The  first  was "Comments on the SDAC Mass Store Retrieval
Guide",  January  17,  1978,  by  Donald    Eastlake.    It
contained  6  pages of detailed comments on the 31 January
1977 edition of the SDAC Mass Store Retrieval  Guide.    It
particularly    urged    SDAC    to    utilize   appropriate
intermediate programs to access  the  Datacomputer  rather
than  to  use  direct human interaction as they were.   The
following is quoted from this comments memorandum:

> "More to the point, perhaps,  this  guide  [SDAC  Mass
> Store  Retrieval Guide] still suffers from an error in
> the philosophy of how  to  go  about  giving  ordinary
> users    access   to   data   in   the   Datacomputer.    For
> example, in 1-2-4-3 and other sections it implies that
> users need to know  about  datalanguage.    While  some
> users' _program_ and those who wrote it need to know all
> about datalanguage, the right way to provide access is
> to  provide  a program that has a convenient interface
> (terminal interactive, batch command  file  drive,  or
> whatever  else  is  appropriate) for the user and that
> composes  the  datalanguage  requests.    This  program
> would  respond to, and in some cases translate for the
> user, datalanguage replies."

The second memorandum was "TBM drive  allocation  and  the
SWF",  20  March 1978, by Donald Eastlake.  It was a brief

two page note that discussed TBM capacity in comparison
with expected SWF data volume and reviewed the results of
all reasonable strategies for TBM drive allocation to
various expected data streams.

3.4  Other Assistance

CCA remained in periodic telephone contact with the Vela
Seismological Center, the Seismic Data Analysis Center,
and the Lincoln Laboratories Applied Seismology Group. On
occasion, off line TBM tapes were temporarily mounted for
LL-ASG and assistance was given them in tracking down some
Datacomputer user problems.

Telephone contact with VSC and SDAC was primarily related
to the SWF. Through such contacts it was decided later in
the year to abandon the table look up approach to
determining how large a data window CCA was to move into
the SWF for an arrival. Instead, the amount of data
before and after the expected arrival time will be
indicated in ESF fields that are overwritten after
successfully moving the indicated data into the SWF.

It was also decided to remove inversions from the fields
in the Event Summary File that would be updated by CCA

after moving data to the SWF. CCA had previously
recommended that these and some other inversions be
removed as unnecessary and not worth the additional
computation they invoke. Their removal was necessary to
make these inner list fields updatable.

References

[CCA]
        Computer   Corporation  of  America,  Datacomputer
        Version 5  User  Manual,  575  Technology  Square,
        Cambridge, Massachusetts 02139, July 1978.

[DORIN and EASTLAKE]
        R.  H. Dorin and Donald E. Eastlake, III;  "Use of
        the  Datacomputer  in   the   Vela  Seismological
        Network",  Technical  Report  CCA-77-08,  Computer
        Corporation of America, April 15, 1977.

[EASTLAKE]
        Donald  E.  Eastlake, III; "Tertiary Memory Access
        and Performance in  the  Datacomputer",  Technical
        Report CCA-77-11, Computer Corporation of America,
        June 30, 1977.

[EASTLAKE and SATTLEY]
        Donald   E.   Eastlake,  III,  and  Joanne  Z.  Sattley,
        Program Design for SWF-D:   The  Signal  Waveform
        File  Demon, Computer Corporation of America, June
        30, 1978.

[GEOTECH]
        Teledyne   Geotech,  Velanet  ESF/SWF  Processing,
        Contract No.  F08606-78-C-0007, 31 July 1978.

[LINCOLN]
        Lincoln  Laboratories  - Applied Seismology Group,
        ESD-TR-78-64 Semiannual Technical Summary, Seismic
        Discrimination,     31     March     1978,     Lincoln
        Laboratories,     Massachusetts     Institute     of
        Technology, Lexington, Massachusetts 02173.

[MARILL and STERN]
        Marill, Thomas; and Stern, D.H. "The Datacomputer:
        A  Network  Utility",  Proceedings  AFIPS National
        Computer Conference, AFIPS Press, Vol. 44,  1975.

[SATTLEY a]
        Joanne Z. Sattley, "Implementation and Test of the
        SWF-D:   The Signal Waveform File Demon", Technical
        Report   in   progress,   CCA-79-09,   Computer
        Corporation of America, January 1979.

[SATTLEY b]
Joanne Z. Sattley, "Program Listings of the SWF-D:
The  Signal Waveform File Demon", Technical Report
CCA-79-1Ø,  Computer   Corporation   of   America,
January 1979.

A.  PESF File Description


The  following  is  a  prototype for a one day Preliminary

Event Summary File.   The monthly Final Event Summary  File

has the same description except that it has space for more

entries.

```
 SDAC.VELANET.PROTOTYPES.PESF PORT LIST (10,50,300),B=32
EVENT STRUCT,B=32
    EINDEX BYTE,V=I
    EVENTNUM STR(9),B=8,I=D
    ORIGIN STRUCT
        DATE INT(6),B=8,I=D         /* OYYDDD */
        TIME INT(8),B=8         /* HHMMSSCC */
    END
    STANDEVORIGT INT(4),B=8
    NSTA INT(3),B=8
    HYPOCENTER STRUCT
        COMPSOURCE STR(1),B=8,I=D
        EPICENTERCOMP STR(1),B=8,I=D
        LATITUDE STRUCT
            LAT INT(5),B=8    /* XX.XXX DEGREES */

            HEM STR(1),B=8,I=D
        END
        LONGITUDE STRUCT
            LONG INT(6),B=8    /* XXX.XXX DEGREES */
            HEM STR(1),B=8,I=D
        END
        NSTA INT(3),B=8,I=D
        DEPTH STRUCT
            DEPTH INT(3),B=8    /* XXX KM */
            STANDEV INT(3),B=8    /* XXX KM */
            METHOD STR(1),B=8
        END
        CONFIDREGION STRUCT
            SMAJORAXIS INT(5),B=8    /* XXXX.X KM */
            SMINORAXIS INT(5),B=8    /* XXXX.X KM */
            ANGLE INT(4),B=8    /* XXX.X DEGREES */
```

```
        END
        REGION STRUCT
            GEOCODE STR(3),B=8,I=D
            SEISNUM STR(2),B=8,I=D
        END
        BODYWAVE STRUCT
            MBMAG INT(3),B=8      /* X.XX */
            STANDEV INT(3),B=8
            NSTA INT(3),B=8
        END
        SURFACEWAVE STRUCT
            MSMAG INT(3),B=8      /* X.XX */
            STANDEV INT(3),B=8
            NSTA INT(3),B=8
        END
        LOCALMAGNITUDE STRUCT
            MLMAG INT(3),B=8
            SOURCE STR(1),B=8
        END
        PARAM STR(20),B=8
        NPHASE INT(3),B=8
        NARR INT(3),B=8
        ARRIVALS LIST (,500,999),C=NARR
            ARRIVAL STRUCT
                AINDEX BYTE,V=I
                STA STR(5),B=8,I=I
                CHANTYPE STR(1),B=8
                RATE INT(2),B=8,I=I
                CHANID STR(4),B=8,I=I
                GAIN STR(1),B=8,I=I
                COMP STR(1),B=8,I=I
                ASSOCCONF STR(1),B=8,I=I
                DIST INT(4),B=8    /* XXX.X DEGREES */
                AZ INT(4),B=8    /* STA TO EPI XXX.X DEGREES */
                DATASEGSTART STRUCT
                    DATE INT(6),B=8
                    TIME INT(8),B=8
                END
                PHASEARR STRUCT
                    DATE INT(6),B=8,I=I
                    TIME INT(8),B=8
                END
                PHASEID STR(6),B=8,I=I
                PHASENUM INT(2),B=8
                PHASECODE STR(2),B=8,I=I
                AMP INT(7),B=8    /* XXXXXX.X NM PK - PK */
                PER INT(3),B=8    /* XX.X SECONDS */
                RES INT(5),B=8    /* XX.XX SECONDS */
                USAGE STRUCT
                    LOCATION STR(1),B=8,I=I
```

```
                MBUSE STR(1),B=8,I=I
                MSUSE STR(1),B=8,I=I
          END
          WAVEFORMAVAIL STR(1),B=8
      END
   END
END;
```

B.   PSWF File Description


The following is a prototype for a one day Signal Waveform
File.


```
SDAC.VELANET.PROTOTYPES.PSWF PORT          /* SEGMENTED DAILY */

    LIST (50,200,2200) ,B=32
        /* 50 DETECTIONS PER DAY * 2 ARRIVALS/SITE * 22 SITES */

        SIGNAL STRUCT        /* ONE PER SITE PER PHASE */
            ARRIVAL STRUCT
                EVENTID STRUCT        /*EVENT IDENTIFIER*/
                    EVDATE INT(5),B=8      /*YYDDD */
                    EVNUM INT(4),B=8     /* NUMBER */
                EVENTNUM STR(9),VE=EVDATE!EVNUM
                END
                INDEX BYTE,V=I
                STA STR(5),B=8,I=D        /* STATION */
                CHANTYPE STR(1),B=8
                    /* A,B,S,I=ADAPTIVE BEAM,BEAM,SUBARRAY BEAM,
                    INDIVIDUAL INSTRUMENT */
                RATE INT(2),B=8
```

```
          CHANID STR(4),B=8,I=D

              /* BBUU FOR INFINITE VELOCITY BEAMS */

          GAIN STR(1),B=8   /* H,L */

          COMP STR(1),B=8

              /* Z,N,E,T,R,1,2,3 NUMERICS FOR ALPA */

          BEAMAZ INT(5),B=8

              /*  0-360 DEGREES: XXX.XX DEGREES */

          BEAMVEL INT(5),B=8    /* XXX.XX DM/SEC */

          DETECTCONF STR(1),B=8

              /* A,B,C, = SIGNAL, S/N ABOUT 1, S/N LESS THAN 1

            AND SIGNAL SUSPECT; ANALYST SAYS */

          CLIPPED STR(1),B=8 /* Y,N, ANALYST SAYS */

          ARVLPAD STR(1),B=8 /* PAD BYTE */

      END

      DATASEGMENT STRUCT

          START STRUCT

              DATE INT(6),B=8        /* OYYDDD */

              TIME INT(8),B=8        /* HHMMSSCC */

          END

          NSAMP INT(4),B=8

              /* DATA SAMPLES IN DATASEGMENT */

          DATAFORMAT STR(1),B=8

              /* I,G: INTEGER, GAINRANGED */

          SCALEFACTOR INT(8),B=8

              /* XXX.XXXXX NANOMETERS PER LEAST SIGNIFICANT BIT */
```

```
            DATAPAD STR(1),B=8

            TIMESERIES LIST( ,1600),B=16,C=NSAMP

                DATA STRUCT

                DINDEX BYTE,V=I    /*DATA POINT INDEX*/

                DATUM BYTE,B=16

                /* SP: 20 SEC OF NOISE FOLLOWED BY 60 SEC OF SIGNAL

                FOR 20 SAMPLES/SEC DATA.  SP WITH 10 S/S WILL

                USE ONLY 800 16 BIT BYTES.  LP: 300 SEC OF NOISE

                FOLLOWED BY 1300 SEC OF SIGNAL. */

                END

        END

    END;
```

C.   SPDET File Description


The following is a prototype for a month file of SRO short

period data detections.  (See section 2.2.)

```
SDAC.VELANET.PROTOTYPES.SPDET PORT LIST(0,3500,35000),
                                    IA=51,ID=1200,II=5000
  DETECTION STRUCT INDEX BYTE,V=I
    STA STR(5),I=D
    STANDEX BYTE
    SDATE INT(6),I=D
    STIME INT(8)
    SINDEX BYTE
    EDATE INT(6)
    ETIME INT(8)
    EINDEX BYTE
END;
```